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香港海域浮游植物种类多样性与群落动态研究

Species Diversity and Community Dynamics of Phytoplankton in Coastal Waters of Hong Kong

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中文摘要

香港海域是我国的赤潮高发区之一，浮游植物的长期监测是海洋环境调查、海水水质监测、赤潮研究的基础。本论文通过对 2000 年、2002 年和 2004 年，分春、夏、秋、冬四个季节在香港海域采集的浮游植物样品的种类鉴定分析，对香港海域浮游植物的种类多样性、种群分布特征和群落组成结构与动态及其与环境因子的关系等进行了研究，并从生态学角度探讨了香港海域浮游植物群落结构及变动的规律和主要机制。

结果如下：

1．香港海域的盐度在平面分布上有显著的地理差异。根据受珠江口淡水的影响程度，将香港海域分成东部、中部、南部和西部水域，受珠江口淡水影响的程度由西向东逐渐减弱，形成了西部河口性质的水域和东部海洋性质的水域，使不同水域出现了不同的浮游植物群落结构特征。

2．香港海域营养盐水平整体较低，总无机氮和总氮变化范围分别为 0.01～0.96mg/L、0.06～1.17 mg/L，正磷酸盐和总磷变化范围分别为 0.002～0.079mg/L、0.02～0.16 mg/L，硅含量的变化范围是 0.05～3.3 mg/L。与 20 世纪 80 年代末的数据比较有显著下降，而与 1999 年的数据比较则相对稳定。

3．本研究共鉴定到浮游植物 254 种（含变种、变型），其中硅藻 51 属 177 种，甲藻 22 属 64 种，硅鞭藻 3 属 4 种，裸藻 1 属 1 种，针胞藻 2 属 2 种，金藻 1 属 1 种，隐藻 1 属 2 种，蓝藻 1 属 2 种，绿藻 1 属 1 种。硅藻仍然是香港海域浮游植物的主要类群，占总种数的 69.69%。其中，出现种类最多的是角毛藻属（*Chaetoceros*），有 27 种，占 10.63%；但在细胞密度上以骨条藻为优势，占了总细胞密度的 44.69%。

4．与历史资料比较，香港海域浮游植物优势种有一定的变化，由原来的硅藻绝对优势转变为在一定季节和区域出现了甲藻或隐藻占优势的情况。2000 年春季的优势种是伸长斜片藻（*Plagioselmis prolonga*），而夏、秋、冬三季节以硅藻为优势，主要优势种有骨条藻（*Skeletonema* spp.）、微小细柱藻（*Leptocylindrus minimus*）、冰河星杆藻（*Asterionellopsis glaciali*）。2002 年的春季和夏季主要的优势种是骨条藻（*Skeletonema* spp.），而在秋季则出现以微小原甲藻（*Prorocentrum minimum*）为主要优势种，冬季的优势种是冰河星杆藻（*Asterionellopsis glaciali*）

和新月筒柱藻（*Cylindrotheca closterium*）。2004 年的春季、夏季和秋季仍然以硅藻为优势，主要的优势种有旋链角毛藻（*Chaetoceros curvisetus*）、骨条藻（*Skeletonema* spp.）、拟菱形藻（*Pseudo-nitzschia* spp.）和脆根管藻（*Rhizosolenia fragillissima*），但冬季的优势为微小原甲藻（*Prorocentrum minimum*）。

5．香港海域浮游植物数量的季节变化显著，一般春季和冬季的细胞密度较低，细胞密度的高峰均出现在夏季和夏末秋初。2000 年、2002 年和 2004 年的年平均细胞密度分别为 2.65×10^5cells/L、6.90×10^5cells/L 和 7.73×10^5cells/L，呈现出逐年增加的趋势。香港海域浮游植物细胞密度因受珠江口淡水的影响程度不同，在平面分布上表现出一定的差异。东部水域的浮游植物细胞密度季节变化不明显，而中部、南部和西部水域则有明显的季节变化，通常在夏季大量径流注入时形成细胞密度的高峰。

6．从群落组成来看，东部水域甲藻和其他藻类所占比例相对高于其他三个水域；而中部水域、南部水域和西部水域多数季节以硅藻为优势，但其他藻类的比例高于甲藻。

7． 2000 年、2002 年和 2004 年香港海域浮游植物种类多样性指数分别为 2.56、2.54 和 2.17，逐年略呈递减的趋势但总体较稳定。调查期间，群落的多样性指数平均值为 2.42，均匀度平均值为 0. 54，属于中等水平。

8．对香港海域浮游植物细胞密度和叶绿素 a 含量与环境因子（温度、盐度、亚硝酸盐、硝酸盐、氨氮、总氮、总磷、硅 Si、TN/TP、Si/TN、Si/TP）进行了逐步回归，结果表明，香港海域浮游植物细胞密度和叶绿素 a 含量与盐度、硅含量和 TN/TP 值相关性极其显著，说明盐度、硅含量和 TN/TP 值是影响香港海域浮游植物生物量的主要环境因素。

关键词：香港海域；浮游植物；种类；赤潮；生态

Abstract

Hong Kong is one of the coastal areas with frequent red tide events, and long-term monitor for phytoplankton is the foundation for marine environment investigation, water quality control and the red tide studies. In the present studies, various phytoplankton samples were collected and analyzed from the coastal waters of Hong Kong, in four seasons of 2000, 2002 and 2004. Through the species identification of these phytoplankton samples, our studies have been focused on investigating phytoplankton species composition and diversity, population distribution, community structure and dynamics in the relationship with the environmental factors of Hong Kong coastal waters. Based on these studies, we proposed from a view of ecology the main mechanism of phytoplankton community structure as well as the dynamics in Hong Kong coastal waters. The results are as follow:

1. There are significant geographical differences in the horizontal distribution of salinity in Hong Kong coastal waters. Hong Kong coastal area can be divided into eastern, central, southern and western regions, based on different impact from the freshwater of Pearl River. The salinity is gradually weakened from west to east, leading to the formation of limnetic western region and oceanic eastern region. Therefore the different groups of phytoplankton changed in their structural characteristics according to the different water regions.

2. The overall level of nutrients in Hong Kong coastal waters is relative low. Total nitrogen and total inorganic nitrogen varied from 0.01-0.96 mg/L、0.06-1.17 mg/L, respectively. Phosphate and phosphorous varied from 0.002-0.079 mg/L、0.02-0.16 mg/L, respectively. The silicon content is in the range of 0.05-3.3 mg/L. The nutrient level was dramatically reduced compared to that of the end 1980s, but is relative stable compared to that of 1999.

3. Totally, 254 species (including varieties) of phytoplankton were identified. They are including 177 diatom species belonging to 51 genus, 64 dinoflagellate species belonging to 22 genus, 4 silicoflagellate species belonging to 3 genus, 1 englenoid species belonging to 1 genus, 2 rhaphidophyte species belonging to 2 genus, 1

chrysophyte species belonging to 1 genus, 1 cryptomonad species belonging to 2 genus, 1 Cyanophyta species belonging to 2 genus, 1 Cholophyta species belonging to 1 genus. In the waters of Hong Kong, diatoms is the major component of phytoplankton, accounting for of 69.69% of the total species numbers of phytoplankton. Among these, the most frequently appearance diatom genus is *Chaetoceros* (27 species, representing 10.63%); while according to the cell densities, *Skeletonema* is the largest , about 44.69% of total phytoplankton cell densities.

4. Comparing to literature records, the dominant phytoplankton species of Hong Kong coastal waters changed to some extent. Diatom had been reported as the most predominant group in Hong Kong coastal waters. In this study it was shown that in certain seasons, Dinoflagellate or Cryptomonad appeared to be dominant in some sea areas. In the spring of 2000, the dominant species was *Plagioselmis prolonga* (Cryptomonad), while in summer, autumn and winter, the diatom dominated Hong Kong coastal waters, with the dominant species of *Skeletonema* spp., *Leptocylindrus minimus*, and *Asterionellopsis glaciali*. In the spring and summer of 2002, the dominant species was *Skeletonema* spp., while in autumn it was *Prorocentrum minimum*, and in winter the dominant species were *Asterionellopsis glaciali* and *Cylindrotheca closterium*. In the spring, summer and autumn of 2004, diatom still dominated in Hong Kong coastal waters, with the dominant species of *Chaetoceros curvisetus*, *Skeletonema* spp., *Pseudo-nitzschia* spp. and *Rhizosolenia fragillissima*, while in winter Dinoflagellate was the dominant group and the dominant species was *Prorocentrum minimum*.

5. The abundance of phytoplankton showed significant season dependent variation. Generally cell density of phytoplankton appeared lower in spring and winter, but higher in summer and early autumn. In 2000, 2002 and 2004, the annual average of cell density of phytoplankton increased, with the average cell density of 2.65×10^5cells/L, 6.90×10^5cells/L, and 7.73×10^5cells/L, respectively. The horizontal distribution of phytoplankton cell density varied in different sea areas according to the extent of effect exerted by fresh water from Pearl River. Cell density did not fluctuate obviously by seasons in eastern waters, while in central, southern and western waters,